WHAT CAUSED THE EXTREME PCB-CONCENTRATIONS IN BIOTA FROM THE SØRFJORD (WESTERN NORWAY) 2001-2002?

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Introduction

Mighty waterfalls in combination with the deep and ice-free Sørfjord made it possible for profitable industry to develop in the vicinity of Odda (Western Norway). The hydro-electric power company AS Tyssefaldene was established at the beginning of the 20th century and soon new industries were founded. Industrial products from the area have been calcium carbide, calcium cyanamide, aluminium, zinc and titanium oxide. Environment concerns were to follow and the Sørfjord was at one time considered as one of the most metal polluted fjords in the world[1].

The Norwegian State Pollution Monitoring Programme (NSPMP) in the Sørfjord and Hardangerfjord has been continuous since 1979. The Objective of the program is to monitor the environmental changes following remedial actions, to support the environmental authorities in their assessment of potential needs for further remedial actions and to produce a foundation for the food safety authorities in their evaluation of the edibility of fish and shellfish. The Sørfjord has also been monitored since 1987, through the international *Joint Assessment and Monitoring Programme (JAMP)* administrated by the Oslo-Paris Convention (OSPAR).

The industrial activities in the vicinity of Odda have been the major source of different contaminants. The point sources of these contaminants have been well known, with the exception of PCBs.

Materials and methods

Blue mussels (*Mytilus edulis*) were sampled annually in shallow waters at several stations in the Sørfjord through the monitoring activities. Pooled samples (50 individuals) were prepared for each station. Cod (*Gadus morhua*; 25 individuals) were also sampled annually, near Tyssedal. Individual livers were prepared for analysis of PCBs and hepatic ethoxyresorufin-*O*-deethylase (EROD) activity.

PCB analyses were conducted at NIVA, according to Brevik[2] with some modifications. EROD activity was measured fluorimetrically[3] and normalised to protein content in the microsomal fraction, determined according to Lowry[4].

Results and discussion

Results early suggested the presence of a local PCB-source, as blue mussels near Tyssedal accumulated high concentrations (ΣPCB = 86 ng/g wet wt)[5,6]. In 1990, a survey was conducted to identify the potential source of the PCB, however, no specific PCB source was found[7]. Semi-permeable membrane devices (SPMDs) were deployed at different localities in the Sørfjord in 2000. These also showed highest amounts of PCBs near Tyssedal[8].

In 2001, severe PCB-contamination was observed in blue mussels near Tyssedal (ΣPCB_7 = 1132 ng/g wet wt)[6,9]. The time of sampling corresponded with the touching up of the old power station of AS Tyssefaldene , which was designated a national historical monument the previous year and located on the shore of the fjord. Old paint and plaster were removed from approximately 1500 m^2 of the building facade. Measures were taken to prevent release of waste material to the environment. However, some material still entered the fjord within a distance of 50 meters form the mussel sampling site.

The paint/plaster from the power station was shown to contain high concentrations of PCBs ($\Sigma PCB_7 \geq$ 336030 ng/g)[6]. The paint was applied to the power station in the 1960s and contained a now unknown PCB-mixture. The relative concentrations of the PCB congeners (PCB-profiles) in blue mussels sampled 2001-2002 were similar to those in the paint/plaster.

In 2002, four out of 25 cod caught in the vicinity of Tyssedal showed extreme PCB concentrations in the liver (Figure 1)[6]. The other 21 individuals showed PCB-concentrations common for fish from this area[6,10]. Furthermore, these 21 individuals showed different PCB-profiles than the cod with the extreme

concentrations, which were similar to the profiles in the paint/plaster from the power station (Figure 2)[6].

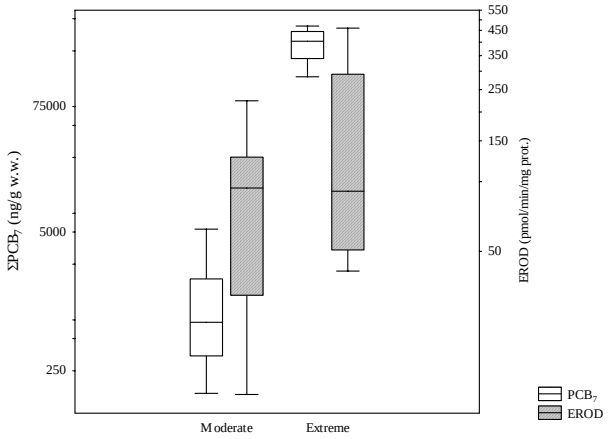

Figure 1. *Median hepatic PCB_7-concentrations (ng/g wet wt.) and ethoxyresorufin-O-deethylase (EROD) activities in moderately polluted (n=21) and extremely polluted (n=4) cod from the Sørfjord. Note dual axes (both logarithmic). The boxes depict quartiles and the whiskers 95%-percentiles. Data from Ruus et al.*[6].

Cod with extreme PCB concentrations generally did not show any increased EROD activity (Figure 1)[6]. This finding indicates some limitations of the EROD-assay as a biomarker of PCB contamination (at least for this combination of congeners), as discussed by Kennedy et al.[11]. The results also support the findings of Besselink et al.[12], who showed that PCBs inhibited TCDD-induced EROD activity in flounder (*Platichthys flesus*).

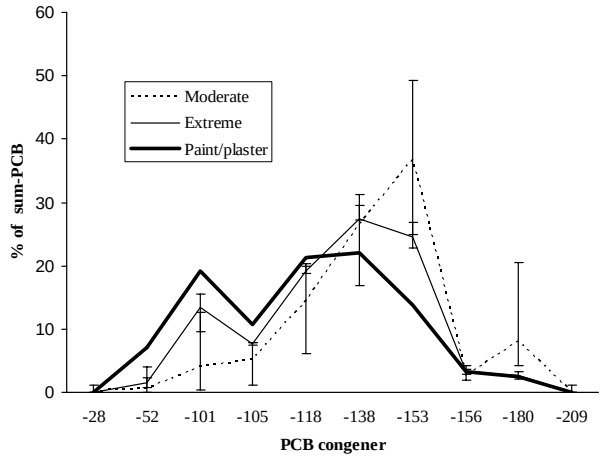

Figure 2. *PCB congener-profiles (% of total concentration; medians) in paint/plaster from the power station in Tyssedal, in moderately polluted cod (n=21) from the Sørfjord, and in extremely polluted cod (n=4) from the Sørfjord caught in 2002. The whiskers depict range. Data from Ruus et al.*[6].

The described values of PCB in blue mussel and cod show the potential for old PCB-containing paint to contribute to serious local pollution if not enough care is taken during remediation. A future scientific challenge will be to understand the specific mechanisms and effects of such PCB accumulation in mussels and fish which is shown in this case[6].

Acknowledgements
The Norwegian State Pollution Monitoring Programme in the Sørfjord is carried out by NIVA for the Norwegian Pollution Control Authority (SFT). Alex Stewart Environmental Services AS serves as subcontractor. The monitoring is funded by the following: SFT, the local authorities in Odda and Ullensvang, Boliden Odda AS, Tinfos Titan & Iron K/S. The *Joint Assessment and Monitoring*

Programme (JAMP) is administrated by the Oslo-Paris Convention (OSPAR). The Norwegian activity is carried out by NIVA, under contract from SFT.

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